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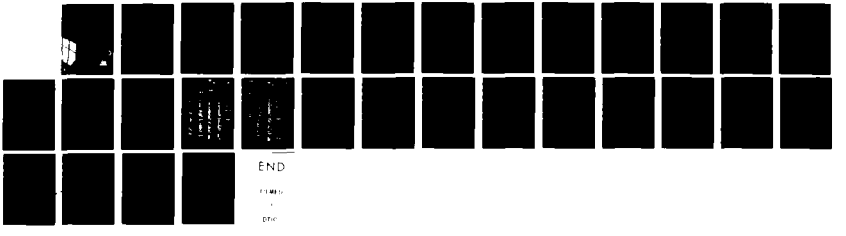

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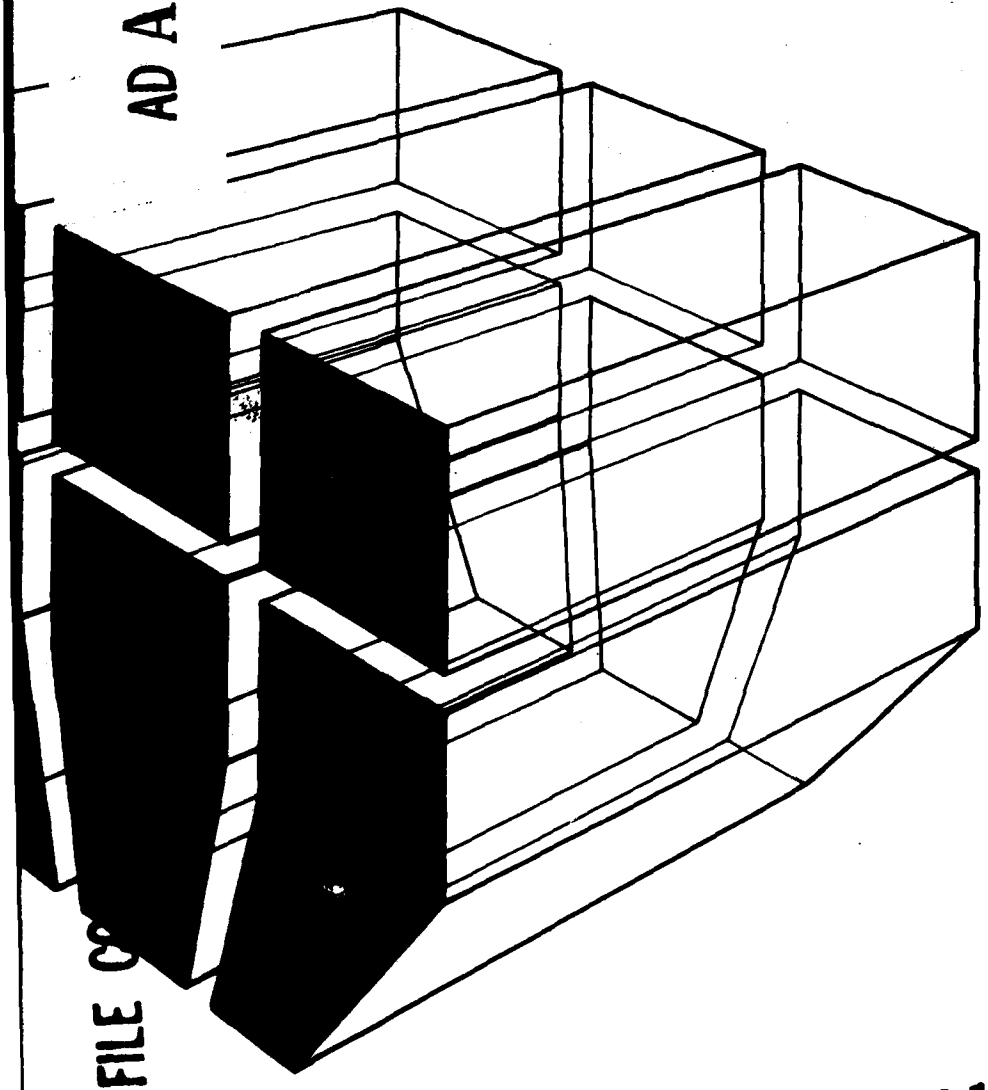
TECHNICAL REPORT N-137
October 1982

AD A122045

COMPARISON OF ALTERNATIVE MODES OF DATA INPUT TO THE PESTICIDE INFORMATION RETRIEVAL SYSTEM



by
M. Messenger
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CERL

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The pilot Pesticide Information Retrieval System (PEST) -- a Component of the Environmental Technical Information System -- was initially developed for Headquarters U.S. Army Training and Doctrine Command to perform keyword searches over a database created from each installation's Pest Control Reports (DD Form 1532). The system can summarize this data by pesticide used, pest, date, installation, location, and several other parameters to produce summary reports containing information on the amount of active ingredient used. Before PEST can be used in the field, an efficient method must be developed

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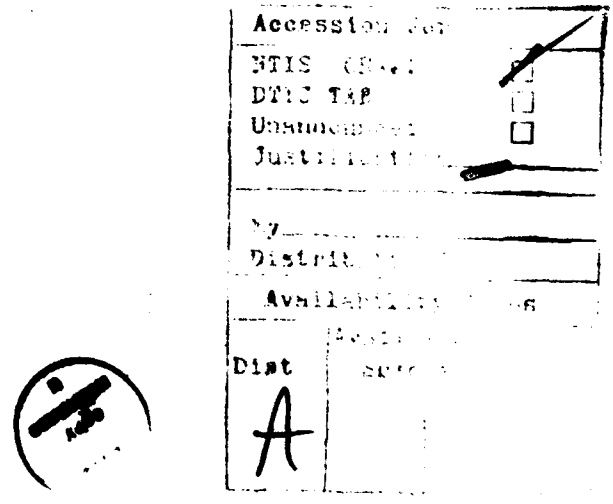
for entering all pesticide application data collected daily at each installation into the system database. This report explores three feasible methods of entering data into this system on a production basis and provides time/cost estimates for these methods. The three methods evaluated were interactive data input, optical mark reading from the installations, and optical mark reading from a central location. It was found that all three methods would reduce the number of steps in the current recordkeeping procedure and that all would reduce the level of error. The scanning at a central location method is the most efficient method, but also the most expensive.

FOREWORD

This work was performed for the Assistant Chief of Engineers under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task A, "Installation Environmental Management Strategy"; Work Unit 034, "Hazardous Materials Management System." The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory. LTC Dennis Gilson, DAEN-ZCE, was the Technical Monitor. Mr. Ben Spencer of TRADOC provided advice and assistance.

Dr. R. K. Jain is Chief of EN. COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.



CONTENTS

COMPARISON OF ALTERNATIVE MODES OF DATA INPUT TO THE PESTICIDE INFORMATION RETRIEVAL SYSTEM

1 INTRODUCTION

Background

The Federal Insecticide, Fungicide, and Rodenticide Act regulates Army pest control operations. AR 420-76[1] implements the provisions of this Act for the Army. The Pest Management Program set forth in this regulation is part of the real property maintenance activities carried out at all Army installations and activities.

The objectives of the Army's Pesticide Management Program are:

1. To develop, start, and maintain safe and effective pest control programs at each Army installation.

2. To maintain and protect the health, environmental quality, aesthetic values, and ecological balance of the military community.

3. To retain and improve operating personnel competence and skill through periodic testing and training.

4. To prevent medical or economic pests from being introduced or spread into the United States, its territories, or possessions by Army operations.

Carrying out the Pest Management Program involves preparing several types of reports. These include the daily and monthly reports on pest management activities required by AR 420-76.

Every pest management operation on an installation is recorded on DD Form 1532-1, the daily report, or on a local form. The information on these forms must be summarized to prepare the required monthly reports; this summarization task is time-consuming and expensive.

To make performance of this task more efficient, the U.S. Army Construction Engineering Research Laboratory (CERL) developed the Pest Information Retrieval System (PEST), an automated system which stores information from DD Form 1532 in a computer database and retrieves these records as needed. (Appendix A provides a pocket users guide for the PEST system.) The system is a component of the Hazardous Materials Management System.*

The system is being evaluated for eventual use in the Department of Defense (DOD) by U.S. Army Forces Command (FORSCOM), U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Defense Acquisition and Readiness Command

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[1] Pest Management Program, AR 420-76 (Department of the Army, 15 December 1980).

* An experimental profile of the Environmental Technical Information System.

(DARCOM), and Army Environmental Hygiene Agency (AEHA). Before the PEST system is used in the field, an efficient method must be developed for entering all pesticide application data collected daily at each installation into the system database.

Purpose

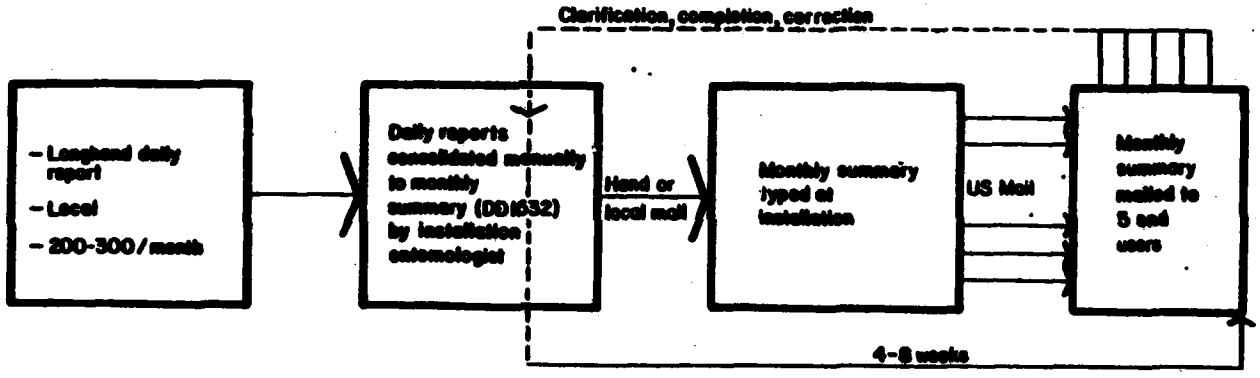
The purpose of this study is to assess the technical feasibility and cost-effectiveness of alternative modes of entering data into the Pesticide Information Retrieval System.

Approach

First, the current flow of information was defined. Data entry methods were then evaluated for conformance with specific criteria developed on the basis of personnel limitations and the need to speed up information transfer and reduce transcription errors. Based on these criteria, three modes of data entry were chosen for assessment: interactive data input from the field directly into the system database, optical mark reading from the installations, and optical mark reading from a central location.

Mode of Technology Transfer

It is recommended that the information in this report be disseminated in accordance with techniques for computer systems defined in AR 18-1, Army Automation Management. The document implementing this system will be an appendix to AR 420-76 or DA PAM 420-76. Current pilot development is being developed in accordance with AR 70-1, Army Research, Development, and Acquisition. Following review and establishment of a Proponent Agency, further system development and deployment will be in accordance with AR 18-1.



					Correction
Personnel:	———	Pesticide applicator	Clerical	Clerical	HQ
Time for task:	———	2-4 weeks	1-2 days	1 week	2-4 months
Equipment/materials:	———	DD form 1532	Typewriter	———	———

Figure 1. Current recordkeeping procedure.

2 CURRENT RECORDKEEPING PROCEDURES

The flow of pesticide application data from installation to end users was defined through discussions with TRADOC personnel, for whom the system was initially developed, and several installation entomologists. Figure 1 shows the current system of recording and summarizing the data, which was developed by the Navy and is used throughout the Armed Forces.[2] Daily reports are completed on a local form by personnel who apply the pesticides as they do the work. The installation entomologist manually reduces these reports into the monthly Pest Control Report (DD 1532). This report is then typed and mailed to the end users: USAEHA, installation HQ, installation MEDAC, HQ MACOM, and the Armed Forces Pest Management Board.

This procedure requires three manual data transformations: (1) creation of the daily reports from work orders by the applicator, (2) consolidation of the daily reports into a monthly summary by the entomologist, and (3) typing of the monthly summary by clerical personnel outside of the entomology office. At each step, standard terms (see Appendix B) must be used to describe the pest control activities. Reports received by CERL for entry into the pilot PEST system often contain incorrect terms or are missing data. One major reason for this problem is that many of the standard valid terms have been arbitrarily assigned and do not bear any immediately apparent relationship to the pests, pesticides, and operations they describe. Once an incorrect term has been entered on a daily report, it is hard to reconstruct what actually occurred. In the final data-handling step, personnel who are unfamiliar with the valid terms and pesticide application procedures must transcribe the handwritten summary.

This process requires 6 to 8 weeks before initial delivery of the monthly summary to the end users. After examining the reports, they may then return them to the installation for clarification, correction, or completion. As a result, the monthly summary may take up to 3 to 6 months to be completed.

Based on identified problems, four criteria were defined for evaluating alternative modes of entering data into the system.

1. Initial data collection must be done in installation entomology operations at current staffing levels.

2. Consolidation of steps in the information flow is desirable, and additional steps are not permissible.

3. Information should be available to the end users more quickly than it is now.

4. The number of times data is transformed manually should be decreased or eliminated, if possible, to reduce transcription errors.

Three modes of data entry were selected to assess their conformance to these criteria: interactive input directly into the PEST system database,

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[2] Pest Management Report Terms, NAVFACINST 6250.3 Series (Department of the Navy, October 1981).

optical mark reading from the installations, and optical mark reading from a central location. Chapters 3 and 4 describe and evaluate these methods and provide an estimate of the costs of using them.

3 INTERACTIVE DATA INPUT

With an interactive data input system, the daily and monthly reports would be handwritten in the entomology office; then the monthly report would be typed directly into the PEST system database via a computer terminal through a WATS line. At this point, the information would be directly available to the end users through the PEST program. Figure 2 illustrates the information flow using interactive data input. This method is technically feasible and has been used at CERL to enter data into the pilot PEST system.

One major advantage of this method is that the PEST program can check the data as it is input to make sure that only valid terms are entered. CERL has developed a data input routine for entering monthly reports into the pilot PEST program. This routine, called "add_data," prompts the user for each piece of information (called a field) contained in the monthly report.

The first field of this routine (field 0) is an accession number which is automatically assigned by the computer for a specific record* so there is no prompt. Field 1, the year and month, is passed to add_data when the routine is called. (See the example interactive add_data session in Appendix C.) Field 2, the installation name, and field 16, the UIC code, are requested once for each installation. These three fields remain the same for all of the installation's subsequent monthly reports. The add_data routine automatically inserts the accession number, date, installation name, and UIC code for the rest of the monthly report entries.

The remaining 12 fields change from record to record. As each piece of data is input, the program checks it against lists of valid terms. If an invalid term is typed in, the add_data program sends an error message to the user, telling him/her that the term is not on the list of acceptable terms; it also gives the user the option of entering another word, or entering the original invalid term. If he/she chooses to enter an invalid term, it will be written into a special file, along with the accession number of the record to which it was added. These files must be examined periodically to determine which terms should be added to the lists of valid terms and which should be sent back to the entomologist for clarification. This gives the system greater flexibility.

Discussions with installation entomologists have revealed several problems with this approach. Generally, no one on the entomology staff has the typing skills needed for data input; therefore, the data must be entered by clerical personnel unfamiliar with pesticide application procedures and valid terms. The typing itself would take about 1 hour per month per installation; however, this is a mixed blessing, because the people involved would not be familiar with data input procedures and would have to relearn them every month (e.g., logging in the terminal, calling up the add_data routine, checking invalid terms, etc.). Depending on the number of errors in the handwritten reports, a lot of time could be spent conferring with the entomology staff to correct them. Another drawback is that a good-quality telephone line, which is needed to communicate with the computer, is not available at DA

* A record is a complete set of 17 fields and represents one line of information on the Pest Control Report (DD 1532).

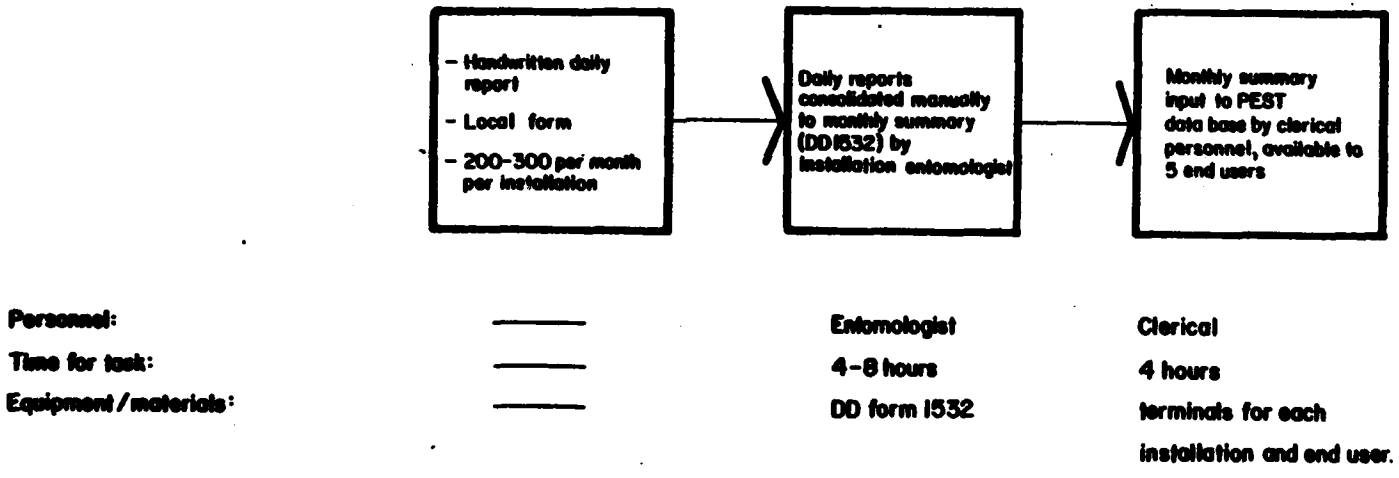


Figure 2. Interactive data input from each installation.

installations. Finally, even though the add_data program flags invalid terms, the chance to introduce errors into the database is not completely eliminated. This is because the monthly report is still produced by manually summarizing the daily reports.

Table 1 summarizes the equipment, labor, and estimated costs associated with using interactive data input. Production of the manual monthly summary requires an estimated 8 hours of labor per month per installation, and input of the final correct monthly report into the system database requires 4 hours of labor per month per installation. The cost of procuring terminals for each installation and the five end users has been included; however, the appropriate type of terminal is already available at most TRADOC, FORSCOM, and DARCOM installations, as well as by the five end users, and would not have to be purchased. The interactive data input method can be used with current staffing levels; however, the level of skill required to use this method will be higher.

Table 1

Cost Comparison:* Alternative Methods of Data Input

METHOD OF DATA INPUT	LABOR		EQUIPMENT/MATERIALS	ESTIMATED COST	
	HOURS/MONTH	TYPE		CAPITAL, $	RECURRING, $/YEAR
Interactive data input from installation	100 hours at $9/hour**	Clerical GS-03	30 terminals @ $700 25 phone lines @ $75	$21,000 terminals 1,875 phone lines $22,875 total	$10,800 data input 33,600 monthly summary $44,400/year total
	200 hours at $14/hour	Assist. Entomologist WG5			
Scanner input from installation	50 hours at $9/hour	Clerical GS-03	7000 forms/month @ $27.15/1000 25 scanners @ $12,500 25 modems @ $1,000 25 phone lines @ $75 5 terminals @ $700	$187,500 scanners 25,000 modems 1,875 phones 3,500 terminals $217,875 total	$ 5,400 labor 2,538 forms $7,938/year total
Centralized scanner input	15 hours at $9/hour	Clerical GS-03	7000 forms/month @ $27.15/1000 1 scanner @ $12,500 1 modem @ $1000 1 phone line @ $75 5 terminals @ $700	$ 12,500 scanner 1,000 modem 75 phone 3,500 terminals $ 17,075 total	$ 1,620 labor 2,538 forms $ 4,158/year total

* Based on 25 installations.

** Administrative and operating overheads included.

4 OPTICAL MARK READING

Optical mark readers (also called optical scanners) transform a series of pencil marks on a predesigned form into computerized information. This type of device is used to read standardized test answer sheets. Figure 3 shows an example scanner form proposed by the Navy for collecting pesticide application data. This form must be designed in conjunction with the scanner manufacturer.

The scanner itself is similar in appearance and operation to a "table top" copying machine. About 500 forms per hour can be read by the smallest scanner available. The forms can be input either manually or automatically. The scanner can be hardwired to the computer, or accessed through a modem over commercial phone lines. This equipment is commercially available and has been used in a wide variety of applications. There are two ways of using optical mark reading to enter data into PEST: either through individual scanners at each installation or through one scanner at a central location.

Individual Installation

Figure 4 shows the information flow resulting if optical mark reading is used at each installation. Pesticide application personnel would mark the daily report directly on scanner forms by pesticide application personnel as the work was completed. A scanner form with carbon copy would replace the local daily report forms now used. The carbons would be kept in the entomology shop, and the originals would be sent periodically to the scanner location, where they would be scanned directly into the PEST database. The PEST program would produce the current monthly summary (DD 1532) at the end of the month; the summary would be available on-line to all end users.

This mode of data input would avoid one of the biggest pitfalls of both the interactive data input and the current recordkeeping procedures; i.e., there would be no manual transformation or summarization of the data. The pesticide applicator would be forced to mark one of the valid terms on the scanner form; this would greatly reduce the amount of incorrect data entered into the system database, as well as the amount of time spent identifying and correcting such errors. Missing data would still be a problem; however, the scanner can be programmed to check all forms for completeness and reject those that are not complete. This is done by printing a message on the form and directing it to a separate output hopper. Furthermore, this system avoids using the mail to transmit the data. Thus, the monthly summary would be available to end users much more quickly, and the labor now used to produce the monthly summary would no longer be needed.

This option is attractive with respect to speed and ease of use; however, it would be expensive to implement. The scanners cost $12,500 apiece for manual feed or $25,000 apiece for automatic feed. In addition, each installation would need modems to connect the scanners to the computer as well as dedicated phone lines. Use of micro-computers at the installation level would eliminate the need for modems; however, conversion of the existing software to operate on various types of micro-computer hardware would also require investigation.

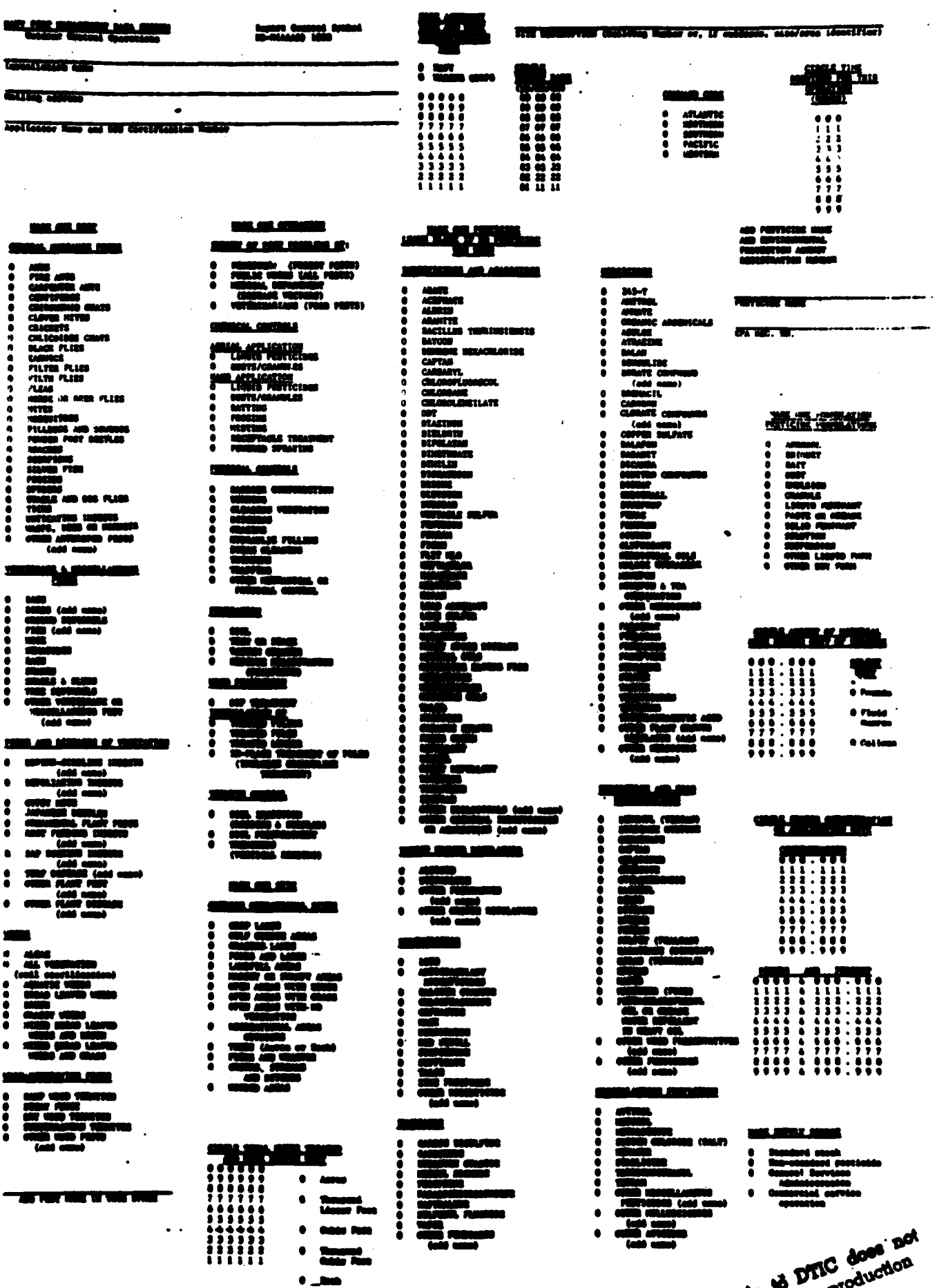


Figure 3. Example scanner form.

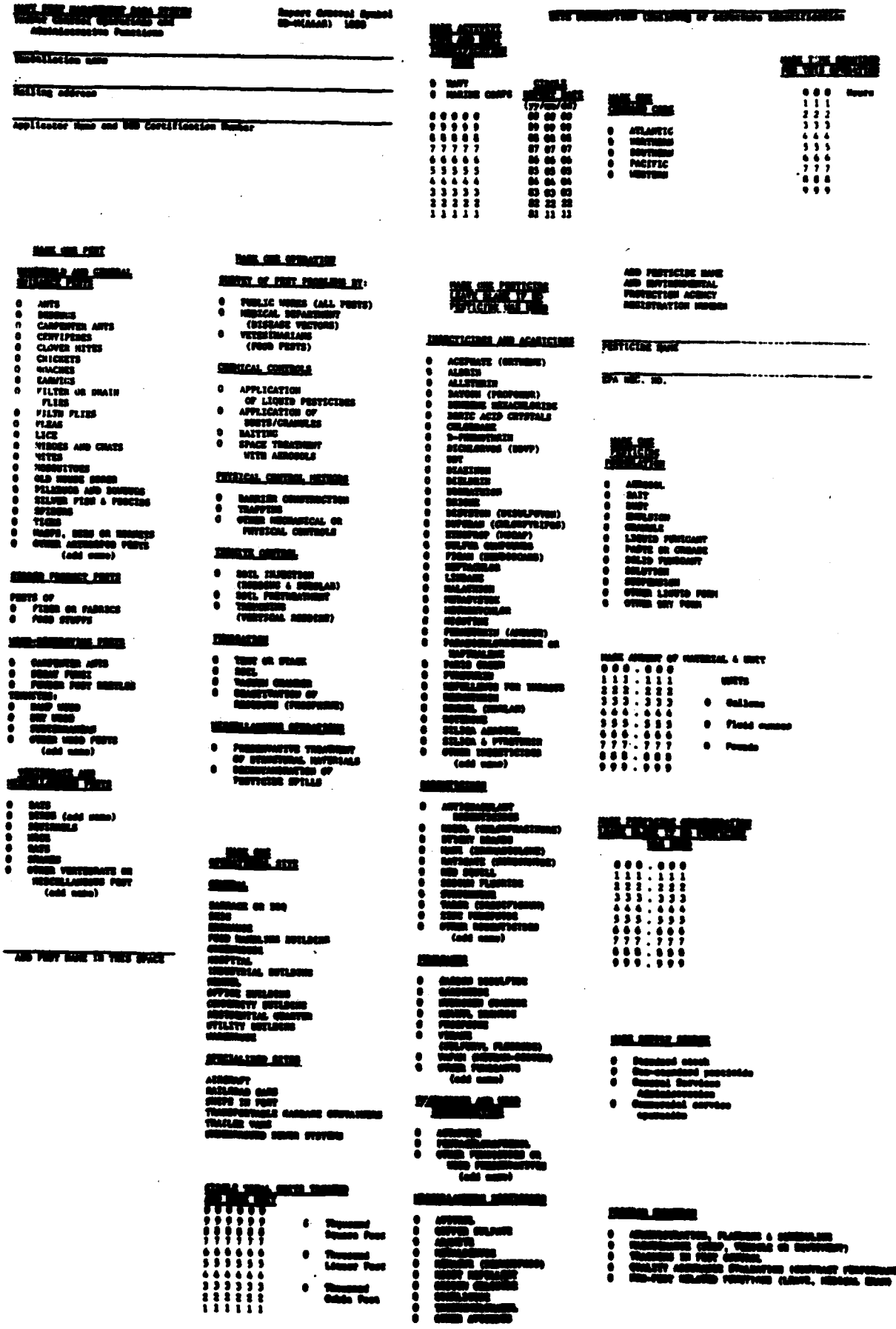


Figure 3. (Cont'd).

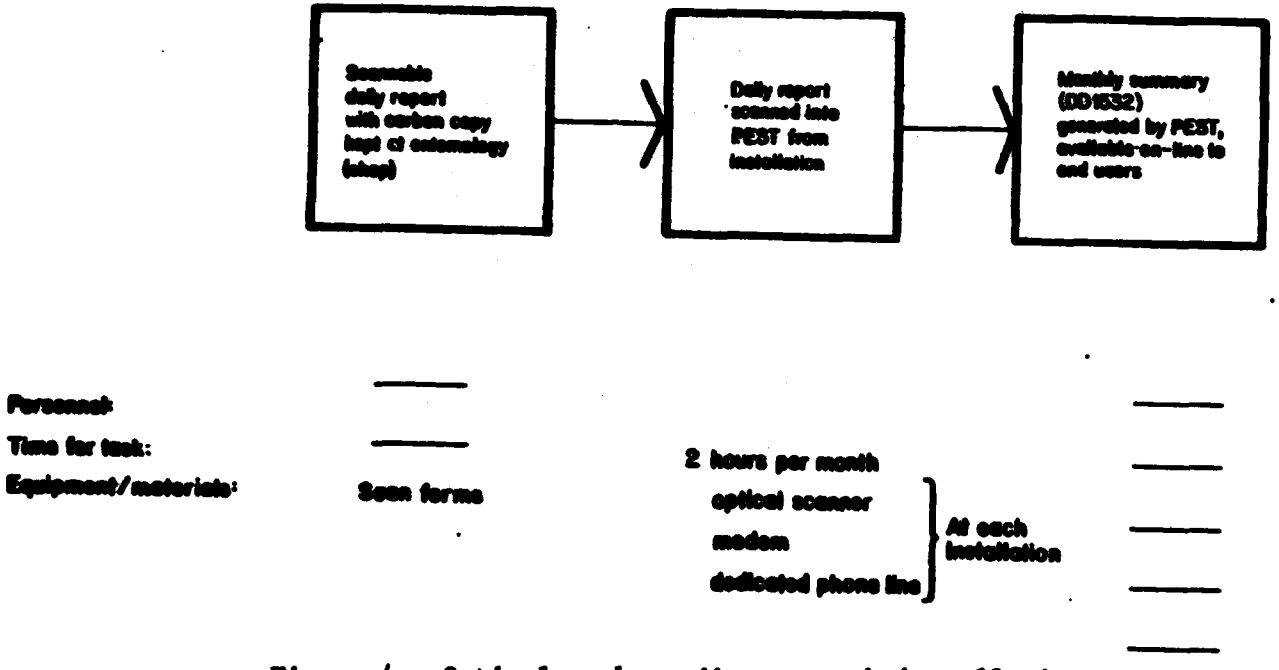
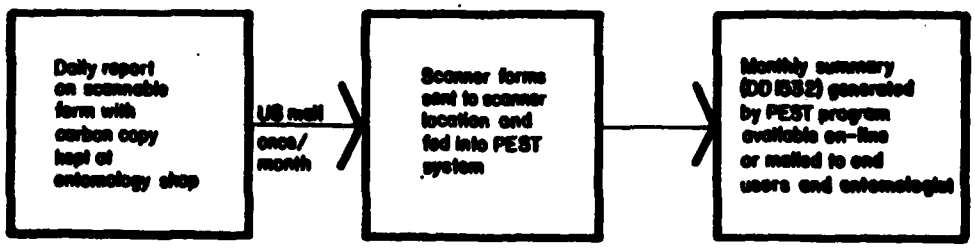


Figure 4. Optical mark reading at each installation.

Since scanner input into PEST has not yet been tried, it should be evaluated at several installations. The cost of such an experiment is outlined in Appendix D. The cost of this option (see Table 1) could be reduced somewhat if the scanner could be used for other jobs besides inputting pesticide application data. While definition of other uses is beyond the scope of this study, its feasibility should be investigated. This would also be particularly useful for other installation-specific database development.

Central Location

Figure 5 shows the flow of information if optical mark reading at a central location is used. Although this option would cost much less than installing a scanner at each installation, it would require using the mail to send data. However, the monthly summary would still be produced by the computer and available to the end users much more quickly than with interactive data input. Only one scanner, one modem, and one dedicated phone line would be needed. Again, no manual transformation of the data would be needed; this would greatly reduce errors and the amount of missing information in the database. Labor costs would also be less than if scanners were used at each installation; this is because set-up and relearning time would be less for one scanner and one operator. Table 1 shows the costs of this alternative.



Personnel:	———	———	———
Time for task:	———	2 days	1 day
Equipment/materials:	Scannable forms replace current local daily logs	1 optical scanner 1 dedicated phone line 1 modem	——— Total

Figure 5. Optical mark reading at a central location.

5 CONCLUSIONS AND RECOMMENDATIONS

This report has assessed the technical feasibility and cost-effectiveness of three modes of data entry for the Pesticide Information Retrieval System: interactive data input, optical mark reading from the installations, and optical mark reading from a central location. For a given installation, the most suitable mode would require consideration of the following factors:

1. Initial data collection can be done in installation entomology operations at current staffing levels for all three methods of data entry.

2. All three methods of data entry would reduce the number of steps in the current recordkeeping procedure (Chapters 3, 4).

3. Both the interactive and scanner methods of data input require better-quality commercial telephone lines that do not run through a central switchboard. The feasibility of installing such lines at DA installations must be determined and implemented before use of this type of technology is considered.

4. The level of error that can be tolerated in the database must be determined. Optical mark reading allows very little error into the database and requires the least amount of human "troubleshooting." Interactive data input also decreases errors, but at the expense of a great deal of human intervention. The current method of recordkeeping allows a great deal of error, much of which is essentially uncorrectable, because due to the time lags between initial data collection and reduction, personnel forget what entries were made.

5. How quickly the monthly report must be available to the end users, and at what expense, is a major deciding factor in choosing a data input method. Scanning at each installation is the quickest method available, but is also the most expensive. Scanning at a central location provides the data quickly and at a reasonable price; it also requires less labor than the other two methods.

6. The skill needed at the installation level is much greater for interactive data input than for scanner input. Whether this skill exists remains to be determined by experimental use of interactive data input at several installations. Hardware and software are available and in-place for this experiment.

It is recommended that both interactive and scanner input be experimentally evaluated at the installation level before a method of data input is chosen. Scanner input into PEST should be evaluated at several installations to determine its advantages and costs.

POCKET PEST (ETIS Pest Information Retrieval System)

Fields

Each field is one kind of information available from the system. You can see the values in each field with the "show" command. Searchable fields can be used with the "find" command.

accession* - system identifier for the data from a single operation.
date - date the pesticide operation was performed; e.g., 80/01
installation - where the operation was performed
pest - target organism
acri* - adult or immature
operation - mode of pesticide application
units_treated - units used to express size of operation
terrain - type of area treated
pesticide - name of pesticide used
formulation - form the pesticide was used in
amount_form - gallons, pounds, or ounces
final_conc* - concentration applied
rate_lbs* - pounds applied per unit area
rate_2* -
conc* - stock pesticide, nonstandard materials, or generator supplied
man_hours* - man-hours spent in application
uic* - installation identifier

* Not a searchable field

Commands

"show <field name>" - lists all the possible values for the field.
"show records" - lists all the database records which have been found.
"show fields" - lists the field names.
"find <value>" - gets all instances of the value. <value> is for any searchable field.
"and <value>" - narrows the records found to those including <value>.
"or <value>" - adds to the records found to those including <value>.
"except <value>" - excludes the records containing <value>.
"list all" or "list <field names>" - lists values of data records at terminal
"display" or "display <filename>" - writes the records found either to the terminal or to a file.
"save <filename>" - saves the results of your search for later use with the "restore" command.
"restore <filename>" - retrieves the results of a previous search.
"help <commandname>" - provides on-line information about the command.
"end", "quit", "bye" ends your PEST session.

Sample PEST Session

1. Log into ETIS, XPER subsystem.
2. Start PEST by choosing PEST from the XPER menu.
3. "show fields" - to see the available fields.
4. "show installation" - to see the installation names.
5. "findmice" - to get all the records for mice.
6. "or rats" - to add the records for rats.
7. "and fort dix" - to get all records for rats and mice abatement at Fort Dix.
8. "except strychnine" - to get all records for rats and mice at Fort Dix except those where strychnine was used.
9. "display" - to see the records at the terminal.
10. "display dixfile" - to write the records to file "dixfile".
11. "bye" - to leave PEST.

APPENDIX B:

VALID TERMS FOR PESTICIDE DATA RECORDS

Installations

carlisle barracks
fort a. p. hill
fort belvoir
fort benjamin harrison
fort benning
fort bliss
fort chaffee
fort dix
fort eustis
fort gordon
fort hamilton
fort knox
fort leavenworth
fort lee
fort leonard wood
fort mcclellan
fort pickett
fort rucker
fort sill
usa support detachment

Pest

algae
allveg
ants
aquaticwds
bats
bdlvdweeds
bedbugs
beetlespp
birds
brgirdsec
brush
carpentant
centipedes
culicoids
dampwdterm
drywdterm
earwigs
fibfabpst
filthflies
fireants
fleas
foodpests
fungiwd
grassyweed
grdsqrls
jpbeetles
leafchewer
lice
marinebor
mice
mites
mosquitoes
mxbdlbrush
mxgrabdlvd
nematodes
oldhousebr

ornplntdis
psychoda
rats
roaches
rodentsoth
rootpests
sapsuckers
scropions
similiids
slvrsocid
snailsluge
spiders
stomoxys
subterms
tabanid
ticks
turfdis
urticating
wob

Operations

atmosfum
barrier
chambar
clearing
dgair
dghand
dgpdeq
diptrlumb
ditching
engdinssur
exbait
exresidtr
extrap
fogging
gltreatmt
hydrafill
inbait
intrap
meddinssur
misting
omcontrol
palldiptr
piinstaltr
pileinpltr
pooinstaltr
poleinpltr
receptreat
residtr
sanitfill
soilfum
spair
spctr
sphand
sppdeq
stinpltr
strucfum
sursoiltr
systemapp
trlumbinst
trnsoiltr
vacuumfum

Bldg/terrain

acf
brq
dew
exc
fhb
gfg
grh
hol
imp
ind
kan
ldf
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Pesticides

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alumphos
amitrole
ammate
anticoag
arsenicorg
aspon
atrazine
attractant
avitrol
bacthuring
baisn
baygon
bensulide
bhc
bnomyl
bromacil
cacn
cadminate
captan
carbaryl
cbisulfide
chlordane
chroneb
clrobenzil
coppersulf
crboxide
creosote
cyclohexim
daconil
dalapon
dchlorvos
ddt
demon
diazinon
dieldrin
difolatan
dimethoate
dinitrocom
dioxat
diquat
dithane
diuron
dyston
dursban
duswetsulf
dyrene
endothall
fenthion
ferbam
fnuron
folpet
hcn
heptachlor
herboil
karathane
kelthane
kepone
koban
kromad
ldarsenate
limesulfur
lindane
m22
malathion
maneb
mbc
mbm
mcb
mcm
mebromide
mesurol
metaldhyde
milkyspore
minoils
mirex
miscoil
mleichydra
monuron
mot
mthoxychlor
naclmollus
naled
napenta
nicotine
nonvpenta
norbromide
orepellent
organsulf
pegel
pentawr
picloram
pon
prisgreen
prometone
pyrethrum
repellimt
resmethrin
ronnel
rotenone
requill
solicaaero
simzine
slvex
sodiumfld
starlicide
strychnine
sulfurylfl
tandex
tbe
tca
thiram
zectran
zineb
znph

Formulations

bqt
bts
dus
eml
grn
lfu
odp
olp
pog
sfu
sln
sus

UIC Codes*

W01569
W01777
W05170
W13355
W13777
W18351
W20491
W21478
W29997
W2LPAA
W34201
W36352
W39220
W40801
W42116
W48083
W51062
W51281
W51359
W51459
W51484

units treated

ac
ea
mcf
mlf
msf
sy

amount_form

ga
lb
oz

*UIC numbers are unique installation identifiers. For example W48083 is Fort Bliss. An installation may have more than one UIC code.

APPENDIX C

SAMPLE INTERACTIVE ADD_DATA SESSION

```
add_data 8109
Type 'quit' to exit
2 installation ? fort knox
3 pest ? filthfly
Sorry 'filthfly' is invalid.
Do you want to add it? no
3 pest ? filthflies
4 A or I ? A
5 operation ? exresidtr
6 no. of units & unit ? 12 msf
7 bldg/terrain ? ken
8 pesticide ? malathion
9 form ? eml
10 amount & unit ? 15 ga
11 final concentration ? 3
12 rate (lbs) ? none
13 rate(%) ? none
14 S,N or C ? S
15 man-hours ? 25
16 UIC code ? W21478
3 pest ? roaches
4 A or I ? A
5 operation ? residtr
6 no. of units & unit ? 214 msf
7 bldg/terrain ? res
8 pesticide ? diazinon
9 form ? eml
10 amount & unit ? 214 ga
11 final concentration ? 1
12 rate (lbs) ? none
13 rate (%) ? none
14 S,N or C ? S
15 man-hours ? 198
3 pest ? quit
Bye . . .
```

APPENDIX D

COST OF EXPERIMENTAL USE OF OPTICAL MARK READER
AT A CENTRAL LOCATION

	6 months	12 months
Rental of one scanner, $740/month	$ 4440	$ 8880
Scanner forms, 1500/month (5 installations)	$ 546	$ 828
Mock-up of scanner form	$ 285	$ 285
Labor		
Installation and interfacing	$ 500	$ 500
Data input	$ 216	$ 432
TOTAL	$ 5987	$10925

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